U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Fisheries Center
2725 Montlake Blvd. E.
Seattle, Washington 98112

December 10, 1975

CRUISE RESULTS

EASTERN BERING SEA SYNOPTIC TRAWL SURVEY

August - October 1975

Cruise C-75-1

CRUISE PERIOD

R/V Miller Freeman--August 11 - October 26

Chartered M/V Anna Marie--July 25 - October 12

Chartered M/V Pat San Marie--July 25 - October 12

ITINERARY

The Miller Freeman departed Seattle August 11 and returned to Kodiak on October 26 to complete the demersal trawling phase of her cruise. Intervening port calls were made at Dutch Harbor on August 17 to pick up scientific personnel and at Adak on September 4-8 and September 28 - October 1 for exchange of scientific personnel and for fuel and other supplies.

The chartered vessels Anna Marie and Pat San Marie departed Seattle July 25. Scientific personnel boarded the charter vessels at Dutch Harbor on August 4. Other port calls were made at Dutch Harbor on September 1-3 and September 19-21 for exchange of scientific personnel and resupply of fuel and water. Scientific personnel departed the charter vessels at Dutch Harbor on October 2. The vessels reached Seattle on October 12 to complete their cruises.

SURVEY AREA

The area surveyed extended from about 62^{o}N and 179^{o}W and south along the continental slope to Unimak Pass and eastward to the Alaska mainland (figure 1).

OBJECTIVES

The three-vessel survey provided baseline information on demersal resources of the eastern Bering Sea as part of the Northwest Fisheries Center's MARMAP program. As such, the survey was designed to satisfy the dual

objectives of providing information to meet requirements of (1) ERL's Outer Continental Shelf Environmental Assessment Program (OCSEAP), and (2) NWFC's continuing assessment of the condition of finfish and shellfish stocks. Funding for this baseline survey was largely provided by OCSEAP.

Specific objectives of the survey were as follows:

1. Describe the distribution and abundance of demersal fish, shellfish, and principal invertebrate resources of the eastern Bering Sea by area and depth.

2. Determine for selected demersal fish and invertebrate populations those parameters, such as stock size, size and age composition, growth rates, and length-weight relationships, which could change from environmental stress.

3. Measure selected oceanographic parameters which may affect the environment and distribution of these populations.

4. The Miller Freeman, in addition to meeting the above objectives, served as a platform for investigations on:
   (a) benthic invertebrates;
   (b) fish diseases;
   (c) marine birds; and
   (d) food habits of demersal fish.

GEAR

Modified eastern fish trawls were used for the survey. The trawls had 112' footropes, 83' headropes, and are constructed of 4" mesh in the wings and body and 3-1/2" mesh in the intermediate and codends. There are 31 8" diameter floats on the headrope and four 25-fathom dandylines, two connected to each wing. The codends are lined with 1-1/4" mesh web for the retention of small fish and invertebrates. Doors were 6' x 9' on the charter vessels and 7' x 10' on the Miller Freeman.

Temperature profiles were made by XBT probes from the Anna Marie and Miller Freeman, and salinity and temperature data at depth were measured by a CTD instrument from the Freeman.

METHODS

The survey was designed to synoptically cover the major part of the ranges of commercially important species of demersal fish and shellfish in the eastern Bering Sea. Depths ranged from less than 20 fathoms in near-shore waters to about 250 fathoms on the continental slope. A stratified-systematic station pattern was used for the survey. Station densities varied depending on the known distribution of main concentrations of the more important fish and shellfish species, the probable location of oil lease sites, and areas with high potential for environmental impact (figure 1). Station densities v

highest (about one per 125 square miles) in waters less than 20 fathoms along the north side of the Alaska Peninsula and in Bristol Bay and lowest in the northeastern extremity of the survey area (one per 1600 square miles in subarea V). In the remainder of the survey area station densities were one per 250 square miles in subareas I, II, and III and one per 400 square miles in subarea IV. One-half hour tows were made at each station.

Methods of processing the catches for fish and miscellaneous invertebrates differed from those used for crabs. For fish and invertebrates other than crabs, catches of less than about 2500 pounds were entirely processed--that is, sorted by species and weights and numbers determined for each species. For larger catches, a sub-sample of about 25 to 50% of the total catch was processed. After the catch was sorted, random samples of selected fish were taken for biological data collection (length frequencies, length-weights, and age structures by sex group). Biological information was taken from the following species of fish:

Pollock (Theragra chalcogramma)
Yellowfin sole (Limanda aspera)
Rock sole (Lepidopsetta bilineata)
Flathead sole (Hippoglossoides ellasodon)
Pacific halibut (Hippoglossus stenolepis)
Pacific cod (Gadus macrocephalus)
Sablefish (Anoplopoma fimbria)
Pacific ocean perch (Sebastes alutus)
Arrowtooth flounder (Atheresthes stomias)
Alaska plaice (Pleuronectes quadrituberculatus)
Greenland turbot (Reinhardtius hippoglossoides)

Commercial species of crab were removed from almost all catches, including those of more than 2500 pounds. These were sorted by species and sex and weights and numbers recorded. All crabs were measured except in the case of large catches when a subsample was taken to provide measurements on a minimum of approximately 300 crabs. In addition to carapace measurements, shell condition, clutch size and egg color were recorded for many of the specimens. Species examined were:

Red king crab (Paralithodes camtschatica)
Blue king crab (P. platypus)
Golden king crab (Lithodes aquispinis)
Tanner crab (Chionoecetes bairdi and C. opilio)
Korean hair crab (Erimacrus isenbeckii)

Also receiving special study were several genera of snails including Neptunea, Baccinum, Volutopsius, Fusitriton, Beringius, and Plicifusus. Gross information on distribution and abundance of other invertebrates such as sea anemone, other crabs, nudibranches, clams, starfish, sand dollars, sea urchins, starfish, sea cucumbers, sponge, and sea pens were also collected by the three vessels. More detailed information on these epibenthic invertebrates was collected on the Miller Freeman by personnel from the Institute of Marine Sciences, University of Alaska.

Six days of intercalibration tests were carried out by the three survey vessels during which 28 comparative tows were completed. Half of the tows were made at 40-70 fathoms and the other half at 75-100 fathoms to detect any differences in relative fishing power between vessels with depth. Alternate tows of one-half and one hour were used to determine if catches from the shorter tows provided the same information as those of longer duration. All aspects of these tests were successfully completed and have provided data adequate to adjust catches from each vessel into a single unbiased data base.

RESULTS

I. Data Collection

Table 1 summarizes the fishing effort and data collection by vessel. During the 148 vessel days in the survey area, 654 tows were made for an average of 4.4 tows per day despite several days of unfishable weather. Of this total, 642 tows were successfully completed without damage to the net that may have resulted in loss of some of the catch. The number of stations in the survey area was 588. Some low priority stations in the northern part of the survey area were not sampled (figure 1). The number of tows exceeded the number of stations because replicate hauls were made at or near some stations during the comparative fishing experiments and some stations were repeated in subarea I at the request of the OCSEAP Office so that requirements of the Institute of Marine Sciences studies on invertebrates could be met. Additional non-standard stations were fished near St. Mathew and St. Paul Islands to examine the availability of blue king crab and Korean hair crabs in these areas.

All catches were processed in the manner described in the methods section. Length measurements were taken from nearly 181,000 fish. Independent otolith or scale and length-weight samples were taken for selected species from five regions of the survey area. The location of these regions was based on prior evidence of the possible existence of independent spawning populations or growth differences for some species in certain of these areas. Samples were completed for pollock, yellowfin sole, flathead sole, rock sole, Alaska plaice and Pacific cod in those regions where the species appeared in adequate numbers. About 7,400 otoliths and 5,900 length-weights were taken.

Carapace measurements were taken from about 81,000 crabs. Most of these were from Tanner crab (74,466) and the remainder from red king crab (6,390) and blue king crab (414).

II. Preliminary Findings

Table 2 summarizes by subarea some preliminary catch figures for the more important commercial species taken during the survey. Pollock predominated the catches in subareas II and III which covered the lower shelf and slope at depths usually exceeding 50 fathoms and ranging out to 240 fathoms. They occurred in almost all hauls and far exceeded other species

in average weight per haul (about 470 pounds/tow in sub-area III and 1200 pounds/tow in subarea II). Other species occurring frequently in catches on the lower shelf, although at much lower abundance than pollock, were Greenland turbot, flathead sole, Pacific cod, and in subarea II arrowtooth flounder. The deeper water species, Pacific ocean perch and blackcod, were taken infrequently and in low abundance in the areas fished. In subarea I and IV on the upper shelf (depths usually less than 50 fathoms), yellowfin sole were clearly the predominate species appearing in nearly all hauls and on the average contributing the major share of the weight to catches. They averaged about 250 pounds per tow in subarea IV and 715 pounds per tow in subarea I. Although much less abundant than yellowfin sole, other species frequently taken in hauls on the upper shelf were Alaska plaice, pollock, Greenland turbot, and rock sole. The occurrence of Pacific cod and flathead sole was also relatively high in subarea I.

Some species were mainly restricted to the shallower waters of the upper shelf whereas others occurred frequently over all depths fished. Yellowfin sole and Alaska plaice were primarily found in waters less than 50 fathoms, whereas pollock, Greenland turbot, flathead sole, Pacific cod, and rock sole generally ranged over most of the survey area. This is illustrated below by the frequency of occurrence of these species in hauls by subarea.

Species	Lower shelf subareas (II)	(III)	Upper shelf subareas (I)	(IV)
Pollock	97	97	83	84
Greenland turbot	92	76	74	55
Flathead sole	92	95	25	58
Pacific cod	63	87	32	65
Rock sole	53	53	71	94
Yellowfin sole	20	41	95	100
Alaska plaice	7	27	87	59

Tanner crab appeared consistently in catches in all subareas, more so on the lower shelf than the upper shelf (Table 2). Their average weight in catches was also relatively high compared to most species of groundfish. Of the two species of tanner crab, C. opilio was by far the most abundant in the northern subareas. The second species, C. bairdi, became more abundant in the two southern subareas and predominated in subarea II.

The occurrence and abundance of king crab was highest in subarea I. Their abundance was also relatively high in subarea II but they were taken in only about 40% of the hauls. Catches of king crab in subareas I and II

were almost entirely red king crab. Those in subareas III and IV were mainly blue king crab. The blue king crab were taken in two localized areas, one near the Pribilof Islands, and the other southwest of St. Mathew Island.

III. Comparison of Survey Results and Objectives

Major objectives of the survey were successfully accomplished. All essential stations in the survey area were covered and catches from each station processed for species weights and in most cases for species numbers to allow descriptions of the distribution and abundance of demersal fish, shellfish, and other epibenthic invertebrates by area and depth. The extensive size and age data collections will describe for major species size and age composition, growth rates and length-weight relationships by regions of the eastern Bering Sea. These data will also provide standing stock estimates by size and age groups. Temperature and CTD profiles taken will provide information on the association of these environmental features with the distribution of species.

Not accomplished during the survey was coverage of stations in subarea V and some stations in the northern portion of subarea IV. These were low priority stations and fishing in adjacent areas indicated that catches at these stations would have been minor. Time was also not available to conduct specific tests on within-block variance. Some data, however, will be available to examine inter-block variance from the comparative fishing experiments.

VESSEL CAPTAINS AND SCIENTIFIC PARTIES

The successful completion of the survey was due in part to relatively good weather over most of the survey period and the lack of vessel and equipment breakdown, but in particular to the outstanding effort of the vessel captains, their crews, and the scientific parties. Those participating in the survey are listed below:

	Anna Marie	Miller Freeman	Pat San Marie
Vessel captains:	Bill Jensen	Cdr. Sig Peterson	Bernie Hansen
Party chiefs:	Steve Hughes Don Gunderson	Robert Wolotira Richard Bakkala Ken Waldron	Jack McBride Doyne Kessler
Fishery biologists:		Mike Tillman Fred Wathne William Gronlund John Garrison John Ploeger Craig Forrest Rene Cerda	Don Day
Biological aides:	Sue Schmidt Eric Brown Steve Kaimmer Mark Wilkins Terry Sample	Kevin Bailey Ralph Carter Dennis Oda Jerry Berger	Gail Turner Bruce Blanchard James Nelson Steve Kaimmer Larry Bartlett

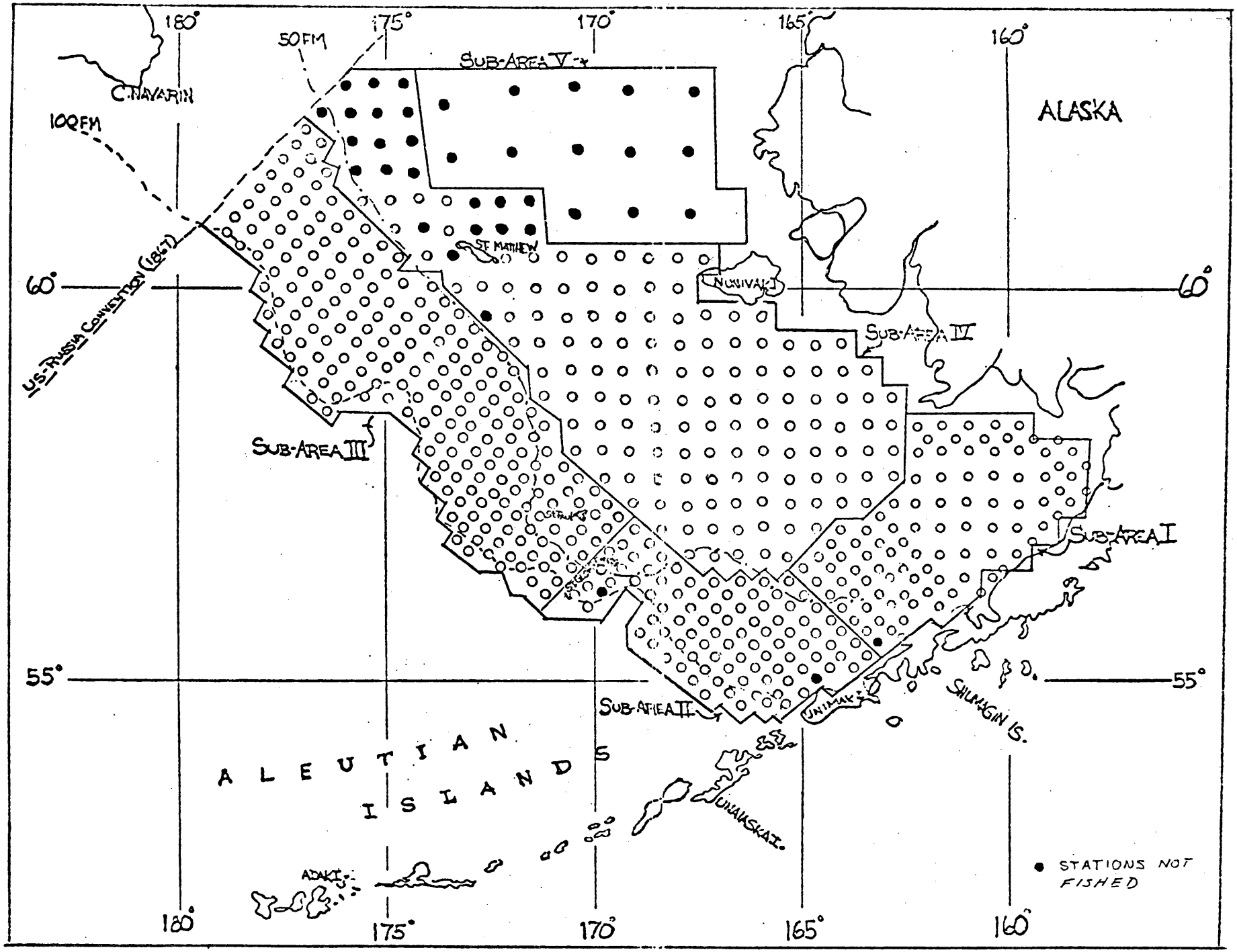

Figure 1.--Sutvey area and stations sampled, BLM-MARMAP demersal trawl survey in the eastern Bering Sea, August-October 1975.

Table 1. Summary of fishing activity and data collection by vessel during the eastern Bering Sea BLM-MARMAP survey, August-October 1975.

Vessel	Days on fishing grounds	Number of hauls	Data collected			
			Groundfish			Crab
			Length Measurments	Otoliths and scales	Length-weights	Carapace Measurements
			(Preliminary numbers)			
Anna Marie	49	224	66,868	3,159	1,542	27,989
Miller Freeman	50	219	76,318	2,139	1,754	27,389
Pat San Marie	49	211	37,648	2,129	2,602	25,892
Total	148	654	180,834	7,427	5,898	81,270

ble 2.--Summary of catches by sub-area (see figure 1) of the principal commercial species of crab and groundfish taken during the BLM-MARMAP trawl survey in the eastern Bering Sea. Figures are preliminary and subject to correction.

Species rank	Occurrence in hauls: Percent	Average catch per 30-min.tow
NORTHWESTERN SUB-AREA (III)		
Depth range 29-240 fathoms		
Total hauls 205		
Groundfish		Pounds
Pollock	97	469
Greenland turbot	92	69
Flathead sole	92	23
Pacific cod	63	28
Rock sole	53	8
Arrowtooth flounder	20	3
Yellowfin sole	20	3
Alaska plaice	7	<1
Pacific ocean perch	3	<1
Blackcod	1	<1
Crabs		
Tanner crab	98	140
King crab	21	4
NORTHEASTERN SUB-AREA (IV)		
Depth range 13-57 fathoms		
Total hauls 133		
Groundfish		Pounds
Yellowfin sole	95	253
Alaska plaice	87	64
Pollock	83	127
Greenland turbot	74	12
Rock sole	71	22
Pacific cod	32	2
Flathead sole	25	5
Arrowtooth flounder	2	<1
Blackcod	0	--
Pacific ocean perch	0	--
Crabs		
Tanner crab	65	84
King crab	15	3
SOUTHWESTERN SUB-AREA (II)		
Depth range 42-210 fathoms		
Total hauls 93		
Groundfish		
Pollock	97	1197
Flathead sole	95	94
Arrowtooth flounder	92	32
Pacific cod	87	47
Greenland turbot	76	16
Rock sole	53	43
Yellowfin sole	41	78
Alaska plaice	27	7
Pacific ocean perch	11	2
Blackcod	6	<1
Crabs		
Tanner crab	96	97
King crab	41	53
SOUTHEASTERN SUB-AREA (I)		
Depth range 15-52 fathoms		
Total hauls 113		
Groundfish		
Yellowfin sole	100	715
Rock sole	94	79
Pollock	84	58
Pacific cod	65	7
Alaska plaice	59	24
Flathead sole	58	11
Greenland turbot	55	5
Arrowtooth flounder	13	1
Blackcod	2	<1
Pacific ocean perch	0	--
Crabs		
King crab	81	128
Tanner crab	64	56